On multistationarity in chemical reaction networks

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In the early eighties René Thomas proposed a rule according to which the possibility for a gene network to display several steady states implies the existence of a positive circuit in its corresponding interaction graph [1]. Several groups have now proved this conjecture in the context of continuous and discrete formalisms.

In this talk, we consider some issues raised by (bio)chemical reaction networks modelled in terms of ordinary differential equations. The Jacobian matrix and corresponding reaction-labelled influence graph [2] of such dynamical systems play a prominent role to characterize their qualitative behaviour.

We present a necessary condition for the occurrence of multiple steady states in (bio)chemical reaction networks in terms of sets of "admissible" circuits in the reaction-labelled influence graph. This result is discussed on several examples. We show that although positive circuits are abundant in (bio)chemical reaction networks only few of them are relevant for multistationarity. Moreover their functionality is context-dependent.

[1] R. Thomas, Springer Series Synergetics (1981) 9,180-193.

[2] S. Soliman, Bull Math Biol (2013) 75, 2289-2303.